

PRELIMINARY DATA SUMMARY

October 1990

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

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CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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## PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

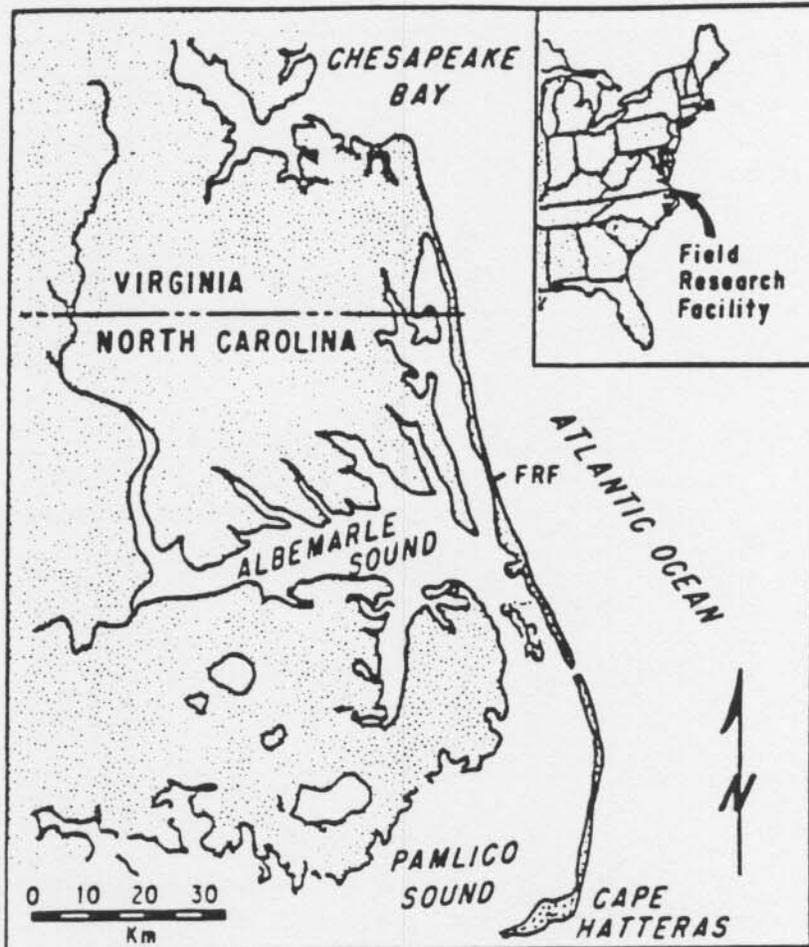


Figure 1. FRF location map

Table 1: Instrument Status/Data Availability

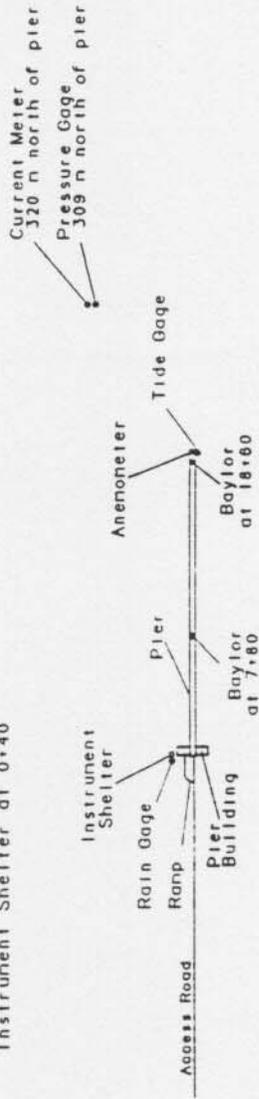
OCT 1990

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																														
				1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	2	2	2	2	2	2	3	3	
616	Barometric Pressure		Gage Status	*																														
			Data Collected	* / / / /																														
			Analog Record	*																														
604	Precipitation		Gage Status	*																														
			Data Collected	* / / / /																														
624	Air Temperature		Gage Status	*																														
			Data Collected	* / / / /																														
932	Anemometer at seaward end of pier Elevation 19 m (NGVD)		Gage Status	*																														
			Data Collected	* / / / /																														
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status	*																														
			Data Collected	* / * / /																														
625	Baylor staff at station 18+60 on FRF pier	see Figure 7	Gage Status	*																														
			Data Collected	* / * / /																														
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*																														
			Data Collected	* / * / /																														
630	Waverider buoy 6.0 km offshore	Approx. 23 m NGVD	Gage Status	*																														
			Data Collected	* / * / /																														
519	Current meter 320 m north of FRF pier (0.9 km offshore)	see Figure 7	Gage Status	*																														
			Data Collected	* / / * * * * * / * * * / * * * * * / / / * /																														
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*																														
			Data Collected	* / / * * * / * * * /																														
Supplemental Observations (daily oceanographic and meteorological observations)			Daily observation	* / / * * * / * * * /																														

Gage Status                      Daily Observation                      Analog Record                      Data Collected  
 Operational = \*                      Complete = \*                      Complete = \*                      All = \*  
 Partial = /                              Partial = /                              Partial = /                              Partial = /  
 Non-Operational = -                      None = -                              None = -                              None = -



Pier Building at 0+40 to 1+00  
 Anemometer at 0+70  
 12 Inch Rain Gage at 0+30  
 Instrument Shelter at 0+40



CURRITUCK SOUND

ATLANTIC OCEAN

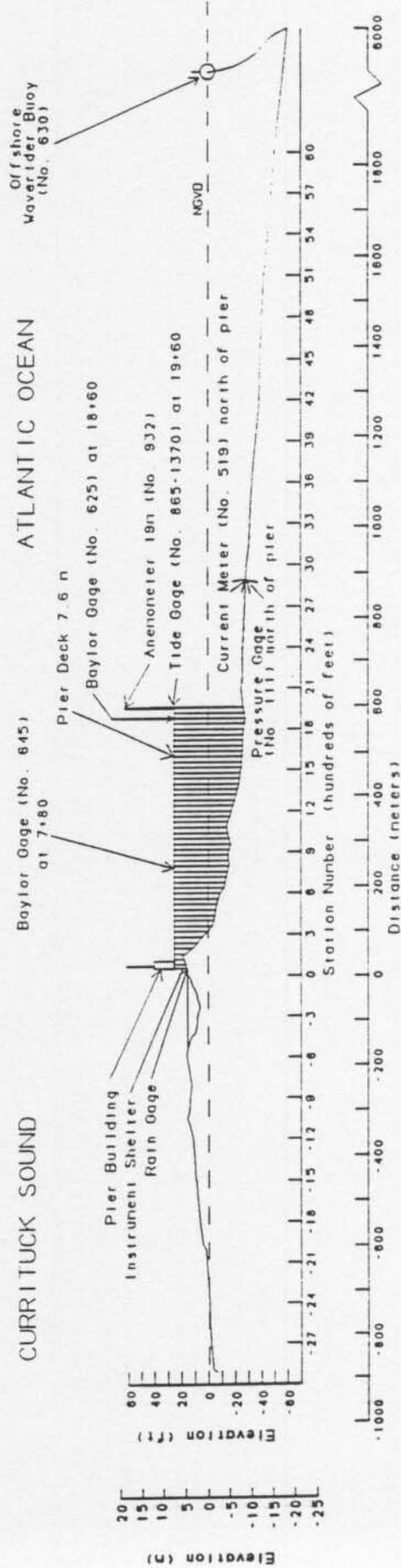


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

## PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $\text{m/s} \times 1.943 = \text{kn}$

Table 2: Meteorological Data

Oct 1990

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	4	275	20.1	1013.8	0
	700	10	357	19.9	1015.9	0
	1300	5	349	20.5	1016.5	0
	1900	2	105	18.6	1015.9	0
2	100	3	206	18.7	1015.9	0
	700	5	247	18.3	1017.2	0
	1300	2	34	24.4	1017.5	0
	1900	7	36	21.2	1019.6	0
3	100	6	45	20.3	1022.6	0
	700	5	64	20.8	1024.7	0
	1300	5	76	23.4	1024.3	0
	1900	8	95	21.4	1023.0	0
4	100	7	135	21.2	1021.9	0
	700	6	132	22.0	1020.9	0
	1300	9	174	26.4	1017.5	0
	1900	8	276	23.4	1015.2	0
5	100	5	252	19.8	1016.2	0
	700	5	27	20.8	1018.6	0
	1300	2	28	24.1	1019.6	0
	1900	3	97	20.8	1018.6	0
6	100	3	180	18.7	1019.2	0
	700	3	195	20.7	1020.3	0
	1300	3	82	26.2	1019.9	0
	1900	5	129	21.8	1019.6	0
7	100	3	137	22.0	1020.3	0
	700	4	174	23.2	1020.9	0
	1300	1	236	28.6	1020.6	0
	1900	5	178	24.9	1020.6	0
8	100	4	203	22.8	1020.9	0
	700	3	167	22.7	1021.3	0
	1300	4	105	27.3	1020.3	0
	1900	5	142	23.6	1020.6	0
9	100	3	159	22.4	1019.9	0
	700	3	158	22.5	1019.2	0
	1300	7	136	28.2	1018.2	0
	1900	5	149	23.6	1017.5	0
10	100	3	138	22.8	1016.9	0
	700	4	128	23.6	1016.9	0
	1300	8	148	26.7	1015.5	0
	1900	10	138	24.7	1015.2	0
11	100	13	136	24.6	1014.5	0
	700	10	151	25.1	1015.9	0
	1300	11	132	27.8	1015.9	0
	1900	5	123	24.3	1016.2	0
12	100	5	129	23.9	1015.5	0
	700	5	70	24.4	1013.8	0
	1300	4	72	25.6	1011.4	0
	1900	7	115	24.5	1009.8	0
13	100	7	127	23.8	1007.4	0
	700	3	31	24.1	1006.7	0
	1300	2	68	26.7	1005.0	0
	1900	3	144	24.0	1005.0	0
14	100	5	210	24.1	1005.7	0
	700	3	276	22.2	1008.1	0
	1300	3	62	26.1	1008.7	0
	1900	3	98	23.3	1010.1	0
15	100	7	223	23.3	1010.8	0
	700	5	232	22.3	1011.8	0
	1300	6	215	26.4	1011.4	0
	1900	3	33	22.8	1013.8	0
16	100	10	6	22.0	1016.9	0
	700	9	2	20.5	1020.9	0
	1300	6	351	21.8	1021.6	0
	1900	6	34	19.9	1021.9	0

\* electronic problems

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Oct 1990

Day	Hour	Wind Speed	Wind Direction	Temperature	Atm Pressure	Precipitation
		m/sec	deg TN	deg C	mb	mm
17	100	5	47	19.9	1023.0	0
	700	8	53	21.4	1023.6	0
	1300	8	108	26.1	1023.0	0
	1900	7	128	21.7	1022.3	0
18	100	7	143	21.4	1019.6	0
	700	8	154	22.4	1015.9	0
	1300	12	174	25.8	1010.4	0
	1900	11	172	23.8	1005.7	0
19	100	10	272	15.3	1009.8	0
	700	9	281	10.9	1014.5	0
	1300	8	302	16.1	1015.9	0
	1900	8	294	13.8	1017.9	0
20	100	8	8	15.5	1019.9	0
	700	7	22	16.5	1021.9	0
	1300	5	6	18.6	1023.0	0
	1900	7	45	16.9	1023.3	0
21	100	8	55	18.5	1023.0	0
	700	5	60	20.5	1022.6	0
	1300	4	74	24.6	1021.6	0
	1900	6	96	21.3	1020.6	0
22	100	1	65	17.4	1019.6	0
	700	4	50	20.8	1018.2	0
	1300	5	62	23.0	1015.9	0
	1900	4	115	21.4	1014.2	0
23	100	5	143	21.5	1011.4	0
	700	8	136	22.0	1007.7	0
	1300	8	184	21.8	1003.7	23
	1900	5	254	19.6	1004.7	0
24	100	2	251	18.4	1006.4	0
	700	5	300	16.8	1009.4	0
	1300	3	8	19.6	1009.1	0
	1900	3	76	18.3	1009.1	0
25	100	5	51	18.8	1007.7	0
	700	8	37	18.4	1005.4	0
	1300	11	23	19.1	1001.0	0
	1900	16	12	18.3	998.9	0
26	100	21	1	16.5	994.5	0
	700	26	344	11.8	996.9	32
	1300	16	324	10.3	1004.3	11
	1900	13	323	10.0	1012.1	0
27	100	9	310	6.9	1016.5	0
	700	9	315	4.2	1020.6	0
	1300					0
	1900					0
28	100			Hardware Error		0
	700					0
	1300	6	239	16.1	1014.8	0
	1900	6	306	12.8	1016.5	0
29	100	12	351	10.8	1019.2	0
	700	9	322	8.3	1020.9	0
	1300	*	*	*	*	0
	1900	8	321	10.0	1022.6	0
30	100	9	11	12.2	1023.0	0
	700	6	316	7.9	1025.0	0
	1300					0
	1900			Hardware Error		0
31	100	5	232	11.5	1021.6	0
	700	5	248	12.2	1021.3	0
	1300	*	*	*	*	0
	1900	3	38	16.0	1020.9	0
		<u>Resultant</u>		<u>Mean</u>	<u>Mean</u>	<u>Total</u>
		1	55	20.4	1015.8	66

\* electronic problems

(Sheet 2 of 2)

### PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height  $H_{m0}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all  $H_{m0}$  and  $T_p$  values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Oct 1990

Day	Hour	645		625		111		630	
		Baylor at 7+80		Baylor at 18+60		Pressure Gage		Offshsr Wvrdr	
		Hmo.m	T.sec	Hmo.m	T.sec	Hmo.m	T.sec	Hmo.m	T.sec
1	0100	0.52	12.19	0.65	9.14	0.78	11.13	0.76	12.19
	0700	1.57	5.69	1.37	5.33	1.59	5.33	1.64	5.57
	1300	1.35	5.95	1.18	6.09	1.30	6.09	1.32	5.45
	1900	0.91	6.92	1.01	13.47	0.93	12.80	1.06	6.56
2	0100	0.81	6.40	0.80	6.40	0.84	11.64	0.94	6.56
	0700	0.56	11.13	0.67	12.19	0.77	11.13	0.76	9.14
	1300	0.38	11.64	0.61	8.26	0.64	11.64	0.62	8.83
	1900	0.47	11.64	0.62	11.64	0.49	11.13	0.61	9.48
3	0100	0.71	4.49	0.72	8.53	0.68	9.14	0.88	4.74
	0700	0.61	4.41	0.60	4.41	0.60	12.80	0.76	9.85
	1300	0.48	3.08	0.59	9.14	0.49	8.83	0.65	8.53
	1900	0.57	3.37	0.70	3.37	0.55	3.66	0.75	3.77
4	0100	0.45	3.41	0.60	3.16	0.56	3.66	0.75	3.66
	0700	0.45	4.00	0.60	7.76	0.56	4.13	0.78	4.00
	1300	0.49	4.74	0.62	4.66	0.63	4.57	0.93	4.27
	1900	0.53	5.12	0.60	5.12	0.68	5.33	0.91	5.12
5	0100	0.27	5.82	0.44	5.82	0.51	6.24	0.66	5.57
	0700	0.55	4.13	0.63	4.00	0.69	4.06	0.75	4.20
	1300	0.40	3.94	0.49	4.34	0.51	12.19	0.61	4.00
	1900	0.42	13.47	0.50	6.09	0.52	12.80	0.64	5.69
6	0100	0.30	12.80	0.45	12.80	0.52	12.80	0.57	12.80
	0700	0.39	12.19	0.51	12.19	0.61	12.19	0.64	12.19
	1300	0.29	11.64	0.42	11.64	0.53	11.64	0.51	11.64
	1900	0.45	11.13	0.53	11.13	0.54	10.67	0.64	11.13
7	0100	0.33	10.67	0.45	10.67	0.58	10.67	0.61	10.67
	0700	0.47	9.48	0.55	10.24	0.62	10.24	0.63	10.67
	1300	0.38	10.24	0.57	9.85	0.60	10.24	0.58	10.24
	1900	0.49	9.48	0.56	9.48	0.58	9.85	0.65	9.85
8	0100	0.39	9.48	0.55	9.48	0.59	9.48	0.65	10.24
	0700	0.61	11.13	0.63	11.64	0.77	10.24	0.76	9.14
	1300	0.58	11.13	0.62	11.13	0.67	10.24	0.75	11.13
	1900	0.61	10.24	0.77	9.85	0.82	10.24	0.91	9.85
9	0100	0.70	11.13	0.75	9.48	0.90	9.48	0.99	9.85
	0700	0.82	10.24	1.05	9.85	1.11	9.85	1.13	9.48
	1300	0.88	10.67	1.10	10.67	1.11	10.24	1.17	10.67
	1900	0.82	9.85	1.05	10.24	1.03	10.24	1.20	10.24
10	0100	0.92	10.24	1.16	9.85	1.22	10.24	1.23	10.67
	0700	0.80	10.24	1.09	9.48	1.12	11.13	1.19	9.85
	1300	0.81	10.67	1.00	10.24	1.21	10.24	1.16	10.67
	1900	1.44	10.24	1.42	7.11	1.71	6.92	1.78	7.53
11	0100	1.79	9.14	1.74	8.00	1.97	7.31	2.06	6.92
	0700	1.83	8.83	1.72	7.76	1.80	8.00	1.99	7.76
	1300	1.25	9.14	1.35	9.85	1.62	9.48	1.75	7.53
	1900	1.19	7.76	1.18	9.14	1.33	8.83	1.46	8.26
12	0100	0.97	8.53	1.13	8.00	1.23	8.53	1.25	8.26
	0700	1.15	8.53	1.21	7.76	1.35	6.56	1.48	6.92
	1300	1.11	15.06	1.35	16.00	1.41	8.00	1.47	8.26
	1900	1.94	13.47	2.28	13.47	2.25	14.22	2.50	13.47
13	0100	2.06	11.64	2.15	12.19	2.51	11.64	2.55	12.19
	0700	2.06	11.64	2.24	11.64	2.05	11.64	2.28	11.64
	1300	1.81	11.64	1.78	10.67	2.15	10.24	2.03	11.13
	1900	1.34	11.13	1.64	10.67	1.73	9.85	1.60	10.24
14	0100	1.21	10.24	1.52	10.24	1.49	10.24	1.42	9.85
	0700	0.84	10.67	1.14	10.67	1.28	10.67	1.11	9.85
	1300	0.76	9.14	0.96	9.85	1.09	9.14	1.16	9.85
	1900	0.93	11.64	1.25	12.19	1.21	11.64	1.28	12.80
15	0100	0.92	10.24	1.06	10.24	1.28	12.19	1.25	11.13
	0700	0.73	9.85	0.93	9.85	1.00	11.13	0.95	12.19
	1300	0.82	11.64	0.90	11.64	0.92	10.67	1.09	11.13
	1900	0.71	11.13	0.81	11.13	0.94	11.13	0.89	11.13
16	0100	0.77	10.24	0.99	10.24	0.99	10.67	1.11	10.24
	0700	1.12	5.82	1.37	5.57	1.43	5.82	1.79	5.45
	1300	0.80	6.09	1.05	9.85	1.20	10.24	1.25	4.92
	1900	0.66	10.24	0.87	10.24	0.86	9.85	0.95	9.14

\* Electronic problems

(Continued)

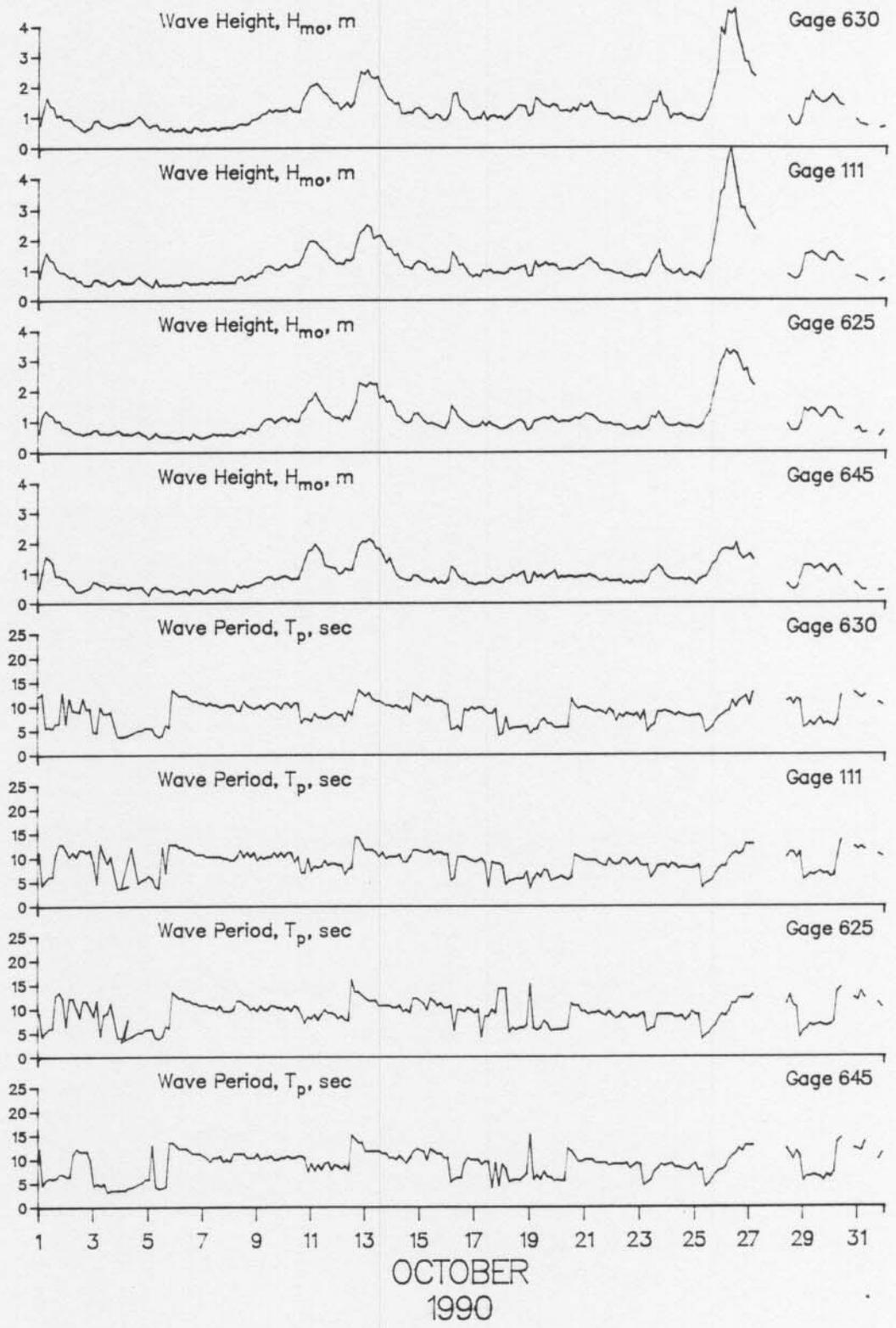
Table 3: Wave Data

Oct 1990

Day	Hour	645		625		111		630	
		Baylor at 7+80		Baylor at 18+60		Pressure Gage		Offshsr	Wvrdr
		Hmo.m	T.sec	Hmo.m	T.sec	Hmo.m	T.sec	Hmo.m	T.sec
17	0100	0.60	9.85	0.83	9.14	0.84	9.14	0.97	9.48
	0700	0.67	8.83	0.98	4.20	0.98	9.85	1.16	9.85
	1300	0.71	9.48	0.99	8.53	1.01	4.00	1.02	8.53
	1900	0.73	9.14	0.83	9.14	0.91	8.83	0.97	9.48
18	0100	0.69	8.83	0.76	14.22	0.86	8.26	0.90	4.41
	0700	0.83	5.22	0.88	5.12	1.06	5.22	1.10	5.22
	1300	0.90	5.69	1.02	5.69	1.05	5.69	1.38	5.69
	1900	1.05	6.24	0.96	6.09	1.15	5.82	1.34	5.82
19	0100	0.68	15.06	0.78	15.06	0.80	3.77	1.10	4.41
	0700	0.86	6.56	1.05	5.57	1.10	6.74	1.53	5.33
	1300	0.82	7.31	1.13	7.53	1.25	7.53	1.35	7.53
	1900	0.99	6.09	1.17	5.45	1.19	5.22	1.41	6.40
20	0100	0.81	5.57	0.97	5.69	0.99	5.82	1.18	5.57
	0700	0.85	5.45	1.01	5.82	1.03	5.82	1.21	5.69
	1300	0.88	11.64	1.05	11.13	1.00	5.95	1.28	11.64
	1900	0.88	9.48	1.09	10.67	1.16	10.24	1.42	9.48
21	0100	0.87	9.85	1.26	9.48	1.31	9.48	1.33	9.85
	0700	0.90	9.85	1.19	9.14	1.25	9.48	1.23	9.14
	1300	0.74	9.14	0.97	9.48	1.01	8.83	1.07	9.14
	1900	0.80	9.14	0.91	8.53	0.98	8.26	1.07	8.26
22	0100	0.73	8.83	0.86	8.53	0.89	8.83	0.90	8.83
	0700	0.75	8.83	0.87	8.26	0.87	8.83	0.95	8.26
	1300	0.69	9.14	0.70	8.83	0.76	9.48	0.89	8.53
	1900	0.70	8.53	0.75	8.53	0.79	9.14	0.80	8.00
23	0100	0.70	8.83	0.72	8.83	0.83	8.53	0.87	7.11
	0700	0.77	5.02	0.85	5.22	0.91	8.53	1.07	4.74
	1300	1.11	7.31	1.10	6.09	1.40	6.92	1.48	6.24
	1900	1.14	8.83	1.11	8.83	1.14	8.53	1.37	8.83
24	0100	0.82	8.83	0.84	8.83	0.93	7.76	0.92	8.83
	0700	0.77	8.26	0.85	8.26	0.89	8.53	1.03	8.00
	1300	0.79	8.00	0.84	8.53	0.81	8.00	0.99	8.26
	1900	0.79	7.76	0.82	8.26	0.88	7.76	0.91	7.76
25	0100	0.60	9.14	0.75	8.83	0.78	8.00	0.84	8.00
	0700	0.84	7.76	0.90	3.66	0.92	3.77	1.01	7.31
	1300	1.07	4.83	1.30	4.92	1.26	5.02	1.53	5.12
	1900	1.39	6.92	2.24	6.56	2.61	6.74	2.42	6.92
26	0100	1.78	7.76	3.08	8.83	3.65	8.26	3.72	8.26
	0700	1.78	9.85	3.19	9.48	5.00	9.85	4.42	9.14
	1300	2.00	11.13	3.22	11.13	3.67	11.13	3.70	9.85
	1900	1.46	11.64	2.65	12.19	3.02	11.13	2.82	11.64
27	0100	1.62	12.80	2.33	12.19	2.54	12.80	2.44	10.24
	0700								
	1300								
	1900								
28	0100								
	0700								
	1300	0.50	11.13	0.71	12.80	0.76	11.13	0.78	11.64
	1900	0.52	11.64	0.71	10.24	0.73	9.85	0.76	11.64
29	0100	1.24	5.22	1.42	5.33	1.53	5.45	1.58	5.57
	0700	1.25	6.24	1.43	6.74	1.61	6.56	1.85	6.74
	1300	1.24	6.74	1.25	6.40	1.51	6.56	1.54	6.74
	1900	1.13	5.45	1.25	6.56	1.29	6.56	1.50	6.24
30	0100	1.17	6.09	1.45	6.74	1.59	5.95	1.73	6.24
	0700	1.10	13.47	1.13	13.47	1.33	10.24	1.42	6.92
	1300	1.06	13.47	1.17	13.47	1.24	13.47	1.22	13.47
	1900								
31	0100	*		0.80	11.64	0.74	11.64	0.76	12.19
	0700	0.41	13.47	0.63	12.19	0.62	11.64	0.69	12.19
	1300								
	1900	0.39	9.85	0.52	11.13	0.62	10.67	0.64	10.67
	Mean	0.88	8.96	1.06	8.97	1.16	8.92	1.24	8.52
	Std dev	0.41	2.71	0.55	2.70	0.68	2.49	0.64	2.48

\* Electronic problems

(Sheet 2 of 2)



#### PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data  
Oct 1990

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
1	0100	Along Cross Result									16 8 18	N on 313
1	0700	Along Cross Result	36 0 36	S	152	122 0 122	S	North	30	S	30 9 31	S off 143
1	1300	Along Cross Result									23 8 24	S off 141
1	1900	Along Cross Result									14 6 15	S off 137
2	0100	Along Cross Result									2 2 3	S off 115
2	0700	Along Cross Result	4 9 10	S off	140	44 13 45	N off	South	8	N	3 3 4	S off 115
2	1300	Along Cross Result									9 8 12	N off 22
2	1900	Along Cross Result									15 4 16	S off 145
3	0100	Along Cross Result									12 2 12	S off 151
3	0700	Along Cross Result	8 10 12	S on	140	28 21 35	N off	South	20	S	9 4 10	S off 136
3	1300	Along Cross Result									1 4 4	N off 56
3	1900	Along Cross Result										
4	0100	Along Cross Result									9 6 11	N on 306
4	0700	Along Cross Result	23 0 23	N	128	47 23 52	N off	South	43	N	10 6 12	N on 309
4	1300	Along Cross Result										
4	1900	Along Cross Result									9 10 13	N on 292
5	0100	Along Cross Result									12 6 13	N on 313
5	0700	Along Cross Result	7 8 10	S on	128	19 5 20	S on	South	5	S	3 4 5	N off 33
5	1300	Along Cross Result									5 3 6	S off 129
5	1900	Along Cross Result									7 4 8	N on 310

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1990

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
6	0100	Along Cross Result									8 4 9	N on 313
6	0700	Along Cross Result	7 7 10	N off 25	128	32 0 32	N	South	30	N	14 5 15	N on 320
6	1300	Along Cross Result									9 2 9	N on 327
6	1900	Along Cross Result									12 7 14	N on 310
7	0100	Along Cross Result									7 4 8	N on 310
7	0700	Along Cross Result	29 7 30	N off 354	140	44 0 44	N	South	58	N	19 8 21	N on 317
7	1300	Along Cross Result									7 4 8	N on 310
7	1900	Along Cross Result									10 8 13	N on 301
8	0100	Along Cross Result									2 3 4	N on 284
8	0700	Along Cross Result	29 0 29	N off 340	152	87 0 87	N	South	61	N	15 6 16	N on 318
8	1300	Along Cross Result									8 1 8	N on 333
8	1900	Along Cross Result									11 5 12	N on 316
9	0100	Along Cross Result									7 1 7	N off 348
9	0700	Along Cross Result	18 9 21	N off 7	152	102 0 102	N	South	76	N	12 6 13	N on 313
9	1300	Along Cross Result									7 3 8	N off 3
9	1900	Along Cross Result									13 7 15	N on 312
10	0100	Along Cross Result									5 3 6	N on 309
10	0700	Along Cross Result	20 10 23	N on 313	152	87 22 90	S on 174	South	63	N	13 2 13	N on 331
10	1300	Along Cross Result									13 1 13	N on 336
10	1900	Along Cross Result									17 8 19	N on 315

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1990

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
11	0100	Along Cross Result									32 6 33	N on 329
11	0700	Along Cross Result	51 0 51	N on 340	165	102 30 106	N on 323	South	76	N	23 9 25	N on 319
11	1300	Along Cross Result									28 7 29	N on 326
11	1900	Along Cross Result									17 6 18	N on 321
12	0100	Along Cross Result									11 1 11	N on 335
12	0700	Along Cross Result	41 12 42	N on 323	152	44 44 62	N on 295	South	61	N	24 2 24	N off 345
12	1300	Along Cross Result									28 3 28	N off 346
12	1900	Along Cross Result									24 0 24	N  340
13	0100	Along Cross Result									14 2 14	N on 332
13	0700	Along Cross Result	5 0 5	N on 340	152	61 0 61	N on 340	South	51	N	11 6 13	N off 9
13	1300	Along Cross Result									17 9 19	N off 8
13	1900	Along Cross Result									2 3 4	S off 104
14	0100	Along Cross Result									2 2 3	N on 295
14	0700	Along Cross Result	32 0 32	S on 160	152	10 8 13	S off 123	North	38	N	12 5 13	S off 137
14	1300	Along Cross Result									8 10 13	S off 109
14	1900	Along Cross Result									7 0 7	S  160
15	0100	Along Cross Result										
15	0700	Along Cross Result	19 0 19	S on 160	152	68 51 85	N off 17	South	9	N	6 7 9	S off 111
15	1300	Along Cross Result									5 2 5	S off 138
15	1900	Along Cross Result									12 14 18	S off 111

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1990

Day	Time	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519			
		Alongshore Cross-shore Resultant		Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
		Speed	Dir										
16	0100	Along Cross Result									32	S	
											10	off	
											34	143	
16	0700	Along Cross Result	41 20 45	S on 187	152	68 0 68	S	North	23	S	40 10 41	S off 146	
16	1300	Along Cross Result									33 9 34	S off 145	
16	1900	Along Cross Result									31 9 32	S off 144	
17	0100	Along Cross Result									18 5 19	S off 144	
17	0700	Along Cross Result	10 0 10	S  160	165	16 0 16	N	South	23	S	12 6 13	S off 133	
17	1300	Along Cross Result									17 1 17	S off 157	
17	1900	Along Cross Result									1 1 1	N on 295	
18	0100	Along Cross Result									9 5 10	N on 311	
18	0700	Along Cross Result	41 20 45	N off 7	140	61 0 61	N	South	53	N	9 6 11	N on 306	
18	1300	Along Cross Result									19 9 21	N on 315	
18	1900	Along Cross Result									30 9 31	N on 323	
19	0100	Along Cross Result									4 1 4	S on 174	
19	0700	Along Cross Result	38 11 40	S off 143	152	61 0 61	S	no observation					
19	1300	Along Cross Result									19 6 20	S off 142	
19	1900	Along Cross Result									15 3 15	S off 149	
20	0100	Along Cross Result									15 4 16	S off 145	
20	0700	Along Cross Result	9 9 13	S off 115	158	24 12 27	S	North	52	S	1 1 1	S on 205	
20	1300	Along Cross Result									14 5 15	S off 140	
20	1900	Along Cross Result									13 3 13	S off 147	

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1990

Day	Time	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
		Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)	Location	Speed	Dir	Speed	Dir
Resultant	Speed	Dir	Distance from Baseline (m)	Speed	Dir						
21	0100	Along Cross Result								19 7 20	S off 140
21	0700	Along Cross Result	28 0 28	S  160	140	5 2 5	S on 187	no observation		26 18 32	S off 125
21	1300	Along Cross Result								31 14 34	S off 136
21	1900	Along Cross Result								24 10 26	S off 137
22	0100	Along Cross Result								21 2 21	S off 155
22	0700	Along Cross Result	19 29 34	S on 216	152	15 11 19	N off 17	no observation		22 8 23	S off 140
22	1300	Along Cross Result								20 2 20	S off 154
22	1900	Along Cross Result								4 3 5	S off 123
23	0100	Along Cross Result								20 6 21	S off 143
23	0700	Along Cross Result	30 8 31	N off 354	165	20 30 37	N off 36	South 63 N		6 1 6	S on 169
23	1300	Along Cross Result								7 3 8	S on 183
23	1900	Along Cross Result								1 5 5	N on 261
24	0100	Along Cross Result								3 2 4	S on 194
24	0700	Along Cross Result	13 0 13	S  160	152	28 7 29	S off 146	South 7 S		7 11 13	N off 38
24	1300	Along Cross Result								5 5 7	S off 115
24	1900	Along Cross Result								6 4 7	S off 126
25	0100	Along Cross Result								13 5 14	S off 139
25	0700	Along Cross Result	6 9 11	S on 216	152	29 15 32	S on 187	North 61 S		4 3 5	S off 123
25	1300	Along Cross Result								14 5 15	S off 140
25	1900	Along Cross Result								40 14 42	S off 141

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Oct 1990

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
26	0100	Along Cross Result									82 27 86	S off 142
26	0700	Along Cross Result	122 0 122	S	177	122 91 152	S on	no observation			137 48 145	S off 141
26	1300	Along Cross Result									85 24 88	S off 144
26	1900	Along Cross Result									55 18 58	S off 142
27	0100	Along Cross Result									41 9 42	S off 148
27	0700	Along Cross Result	36 18 40	S on	177	87 0 87	S 160	North	43 S			
27	1300	Along Cross Result										
27	1900	Along Cross Result										
28	0100	Along Cross Result										
28	0700	Along Cross Result	9 20 21	N on	165	0 5 5	on 250	North	11 S			
28	1300	Along Cross Result									19 13 23	N on 306
28	1900	Along Cross Result									14 10 17	N on 304
29	0100	Along Cross Result									9 1 9	S off 154
29	0700	Along Cross Result	38 6 39	S off	165	55 8 56	S on 169	North	60 S		25 5 25	S off 149
29	1300	Along Cross Result										
29	1900	Along Cross Result									20 2 20	S off 154
30	0100	Along Cross Result									16 2 16	S off 153
30	0700	Along Cross Result	18 4 18	S off	152	51 8 51	S off 151	no observation			14 1 14	S off 156
30	1300	Along Cross Result										
30	1900	Along Cross Result										

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Concluded)  
Oct 1990

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Dye 12m offshore (surface)		Location	Speed	Dir	Speed	Dir
			Speed	Dir		Speed	Dir					
31	0100	Along Cross Result									4 4 6	S on 205
31	0700	Along Cross Result	7 16 18	S off 94	165	44 4 44	S off 154	no observation				
31	1300	Along Cross Result										
31	1900	Along Cross Result										

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore      off = offshore

## PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Oct 1990

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone.m	Water Characteristics at Pier End		
		Primary	Secondary			Temp. C	Density g/cc	Secchi Vis. m
1	0641	25		inoperative	110	23.1	1.0212	0.9
2	0655	90	45	inoperative	58	22.8	1.0214	0.9
3	0700	90	20	inoperative	49	22.8	1.0209	1.8
4	0715	100	80	inoperative	40	23.1	1.0211	2.1
5	0700	10	40	inoperative	40	22.2	1.0220	3.0
6	0832	90	65	inoperative	40	25.6	1.0222	1.8
7	0846	90		inoperative	62	23.3	1.0221	1.5
8	0650	90	120	inoperative	67	23.3	1.0226	1.8
9	0700	90		inoperative	91	24.4	1.0231	1.5
10	0745	90		inoperative	94	24.1	1.0232	1.5
11	0725	95		inoperative	320	23.9	1.0232	0.9
12	0655	95		inoperative	105	23.9	1.0234	2.4
13	0700	100		inoperative	401	24.4	1.0234	0.9
14	0748	85		inoperative	116	25.0	1.0226	6.4
15	0724	100		inoperative	107	23.9	1.0212	6.7
16	0810	35	95	inoperative	119	23.3	1.0208	2.1
17	0805	60	85	inoperative	113	22.8	1.0209	2.4
18	0832	95	110	inoperative	110	23.9	1.0226	2.4
19	0752	30	90	inoperative	110	22.5	1.0240	0.9
20	0800	35	55	inoperative	94	21.7	1.0237	1.2
21	0810	90	35	inoperative	116	21.1	1.0210	2.4
22	0750	95	65	inoperative	84	21.1	1.0205	5.2
23	0800	100	125	inoperative	110	21.7	1.0212	2.4
24	0805	100	30	inoperative	119	18.9	1.0232	4.6
25	0805	40	100	inoperative	111	21.7	1.0230	2.4
26	0754	35		inoperative	491	17.8	1.0200	0.3
27	0754	50		inoperative	256	17.8	1.0216	0.6
28	0810	65		inoperative	143	17.2	1.0204	0.3
29	0825	50	20	inoperative	122	17.2	1.0230	0.3
30	0825	60	40	inoperative	125	16.1	1.0232	0.6
31	0832	80		inoperative	101	16.1	1.0220	2.1

## PART VI: WATER LEVELS

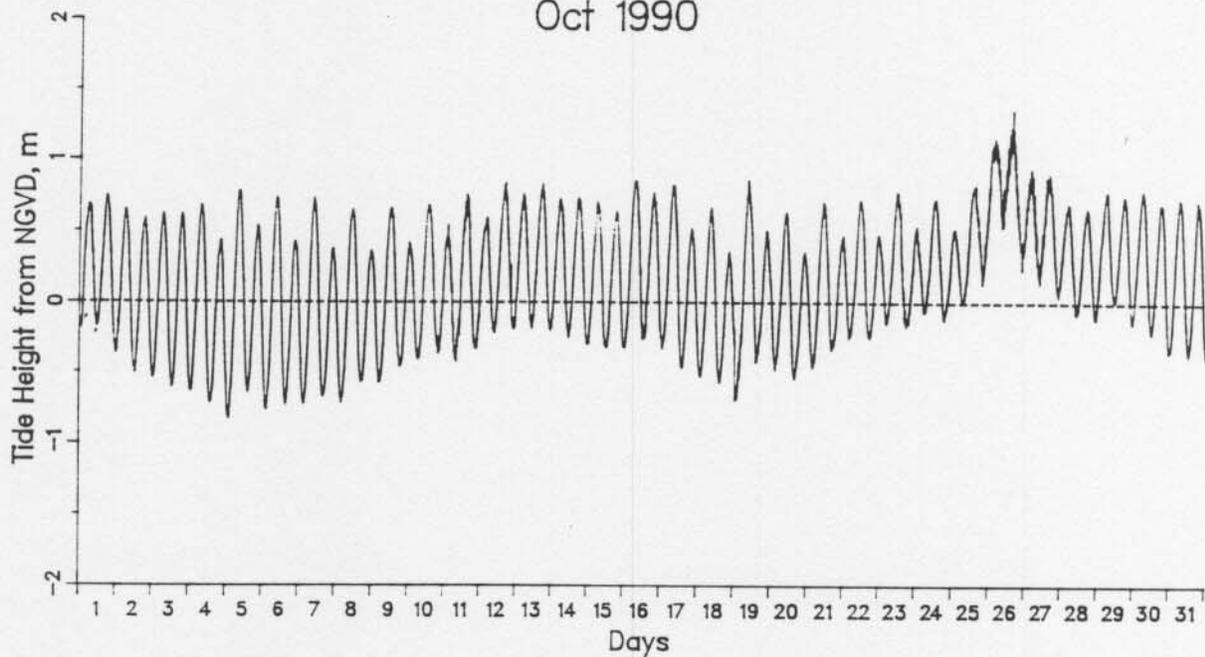
Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

# FRF Tide Heights

Oct 1990



## Monthly Water Levels, m NGVD

Extreme Low = -0.83 on day 5 at 106 EST  
Extreme High = 1.35 on day 26 at 1306 EST  
Monthly Mean = 0.17  
Mean Low = -0.34  
Mean High = 0.68  
Mean Range = 1.02

Table 6: Water Levels.m NGVD

		Oct 1990			
Mid-Cycle		Low	High	Mean	Range
Day	Time				
1	612	-0.18	0.68	0.24	0.86
1	1837	-0.36	0.74	0.22	1.10
2	703	-0.50	0.65	0.10	1.15
2	1928	-0.54	0.59	0.03	1.12
3	753	-0.61	0.62	0.03	1.23
3	2018	-0.63	0.61	-0.02	1.25
4	843	-0.72	0.68	0.00	1.39
4	2109	-0.83	0.43	-0.19	1.26
5	934	-0.64	0.78	0.07	1.42
5	2159	-0.77	0.53	-0.11	1.30
6	1024	-0.73	0.73	0.02	1.46
6	2249	-0.73	0.43	-0.14	1.16
7	1115	-0.67	0.73	0.02	1.40
7	2340	-0.72	0.38	-0.17	1.09
8	1205	-0.57	0.65	0.03	1.22
9	30	-0.57	0.36	-0.10	0.94
9	1255	-0.46	0.66	0.11	1.12
10	121	-0.40	0.42	-0.01	0.82
10	1346	-0.36	0.68	0.19	1.04
11	211	-0.42	0.54	0.04	0.96
11	1436	-0.33	0.75	0.20	1.08
12	301	-0.23	0.59	0.17	0.82
12	1527	-0.19	0.83	0.33	1.02
13	352	-0.18	0.75	0.28	0.94
13	1617	-0.20	0.83	0.32	1.02
14	442	-0.25	0.72	0.25	0.97
14	1707	-0.30	0.73	0.24	1.03
15	532	-0.32	0.70	0.19	1.02
15	1758	-0.32	0.65	0.15	0.97
16	623	-0.26	0.85	0.31	1.10
16	1848	-0.33	0.76	0.22	1.09
17	713	-0.47	0.82	0.22	1.29
17	1938	-0.53	0.52	-0.01	1.05
18	804	-0.57	0.66	0.06	1.23
18	2029	-0.69	0.36	-0.15	1.05
19	854	-0.42	0.85	0.19	1.27
19	2119	-0.48	0.50	0.01	0.98
20	944	-0.54	0.63	0.05	1.17
20	2210	-0.46	0.35	-0.07	0.81
21	1035	-0.34	0.70	0.18	1.04
21	2300	-0.25	0.47	0.08	0.72
22	1125	-0.25	0.72	0.23	0.97
22	2350	-0.14	0.48	0.15	0.62
23	1216	-0.16	0.77	0.30	0.94
24	41	-0.06	0.53	0.20	0.59
24	1306	-0.12	0.73	0.31	0.84
25	131	0.00	0.52	0.24	0.52
25	1356	0.14	0.82	0.51	0.68
26	222	0.47	1.15	0.86	0.68
26	1447	0.23	1.35	0.80	1.12
27	312	0.14	0.94	0.55	0.79
27	1537	0.05	0.90	0.50	0.85
28	402	-0.08	0.69	0.33	0.77
28	1628	-0.11	0.66	0.28	0.77
29	453	0.01	0.78	0.37	0.77
29	1718	-0.14	0.75	0.32	0.89
30	543	-0.21	0.78	0.30	1.00
30	1808	-0.35	0.69	0.18	1.04
31	634	-0.37	0.73	0.20	1.10
31	1859	-0.39	0.71	0.18	1.11

## PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in September and the only survey in October on profile line 188, located 517 m south of the pier. The nearshore bar (160 - 300 m) migrated 90 m seaward, this following the intense storm on 26-28 October. Offshore some erosion is visible seaward (320 - 480 m) of the nearshore bar.

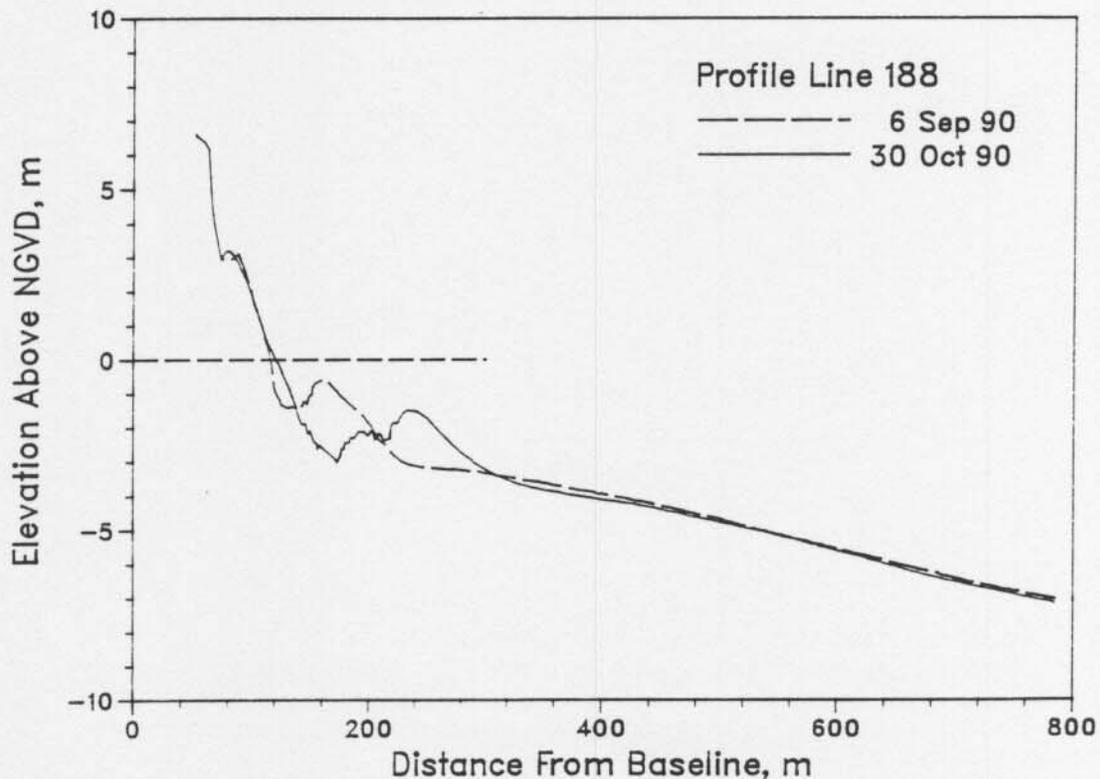


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1990. The changes in the nearshore (at 160 m and 240 m) are a result of the seaward movement of the nearshore bar. Erosion offshore (400 m) is also visible.

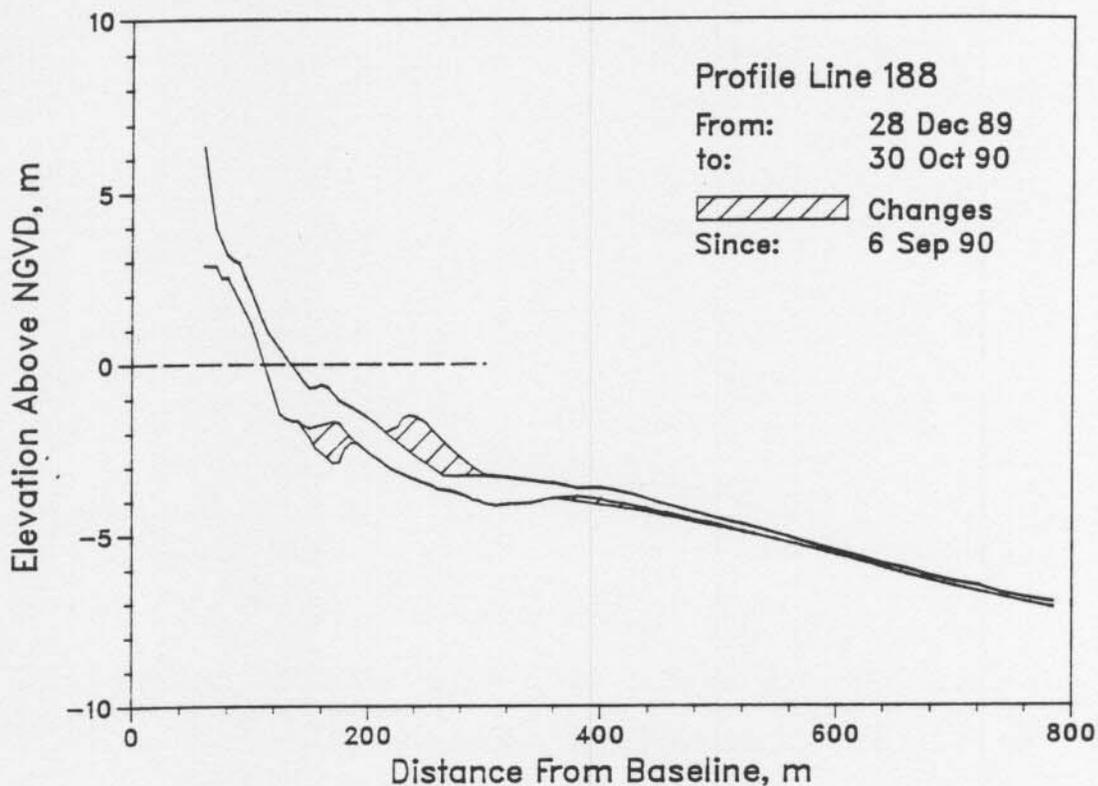


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 31 October. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

## PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured at the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
12 Oct (1725)	13 Oct (1216)
25 Oct (1634)	27 Oct (0633)

### B. Storm Synopsis.

12-13 October - Large waves generated by Hurricane Lili arrived on the North Carolina coast late on 12 October. Remaining well offshore Lili turned north on 13 October no longer posing a threat to the coast. Because the storm remained well offshore the only effects to the FRF were the increased wave heights. The maximum  $H_{mo}$  (at gage 625) of 2.44 m ( $T_p = 12.88$  sec) occurred at 2133 EST on 12 October.

25-27 October - Forming over South Carolina early on 25 October this strong storm slowly moved offshore where it quickly intensified and slowly moved up the coast, being centered off Cape Hatteras, NC on the morning of 26 October. By 27 October the storm was located off New England. Peak winds approaching 21 m/s were recorded at 0434 EST on 26 October with the maximum  $H_{mo}$  (at gage 111) of 5.00 m ( $T_p = 9.85$  sec) occurring several hours later at 0700 EST. Total precipitation was 43 mm.

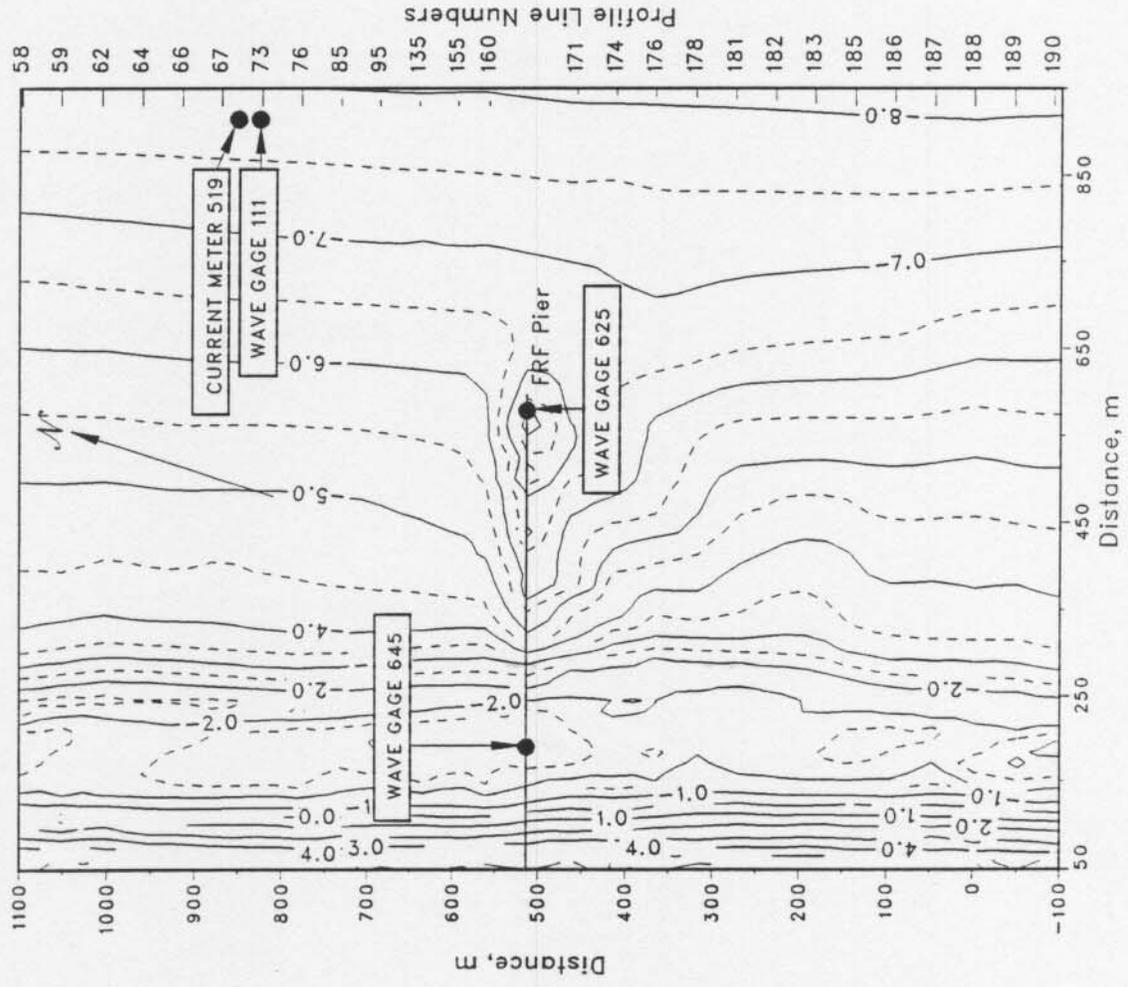
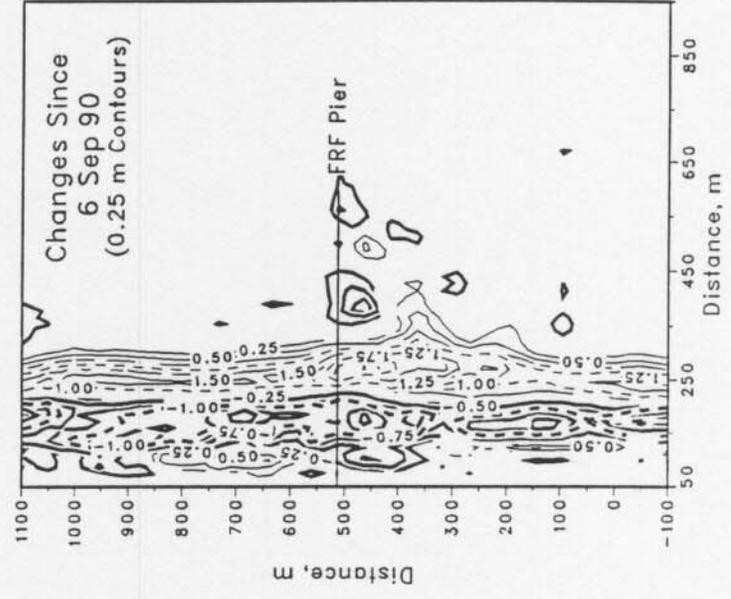
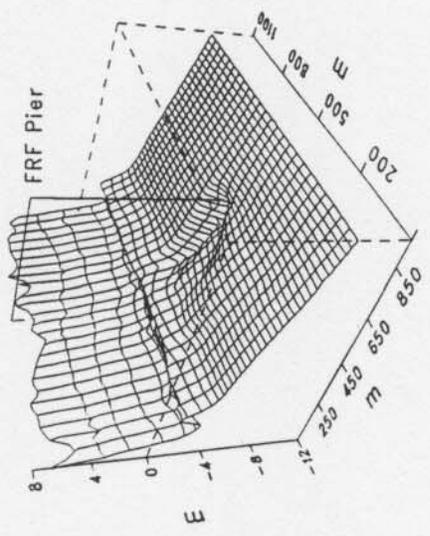


Figure 8. FRF bathymetry 31 Oct 90 depths relative to NGVD

## Distribution List

### Government Agencies:

OCE	U.S. Geological Survey
BERH	U.S. National Park Service
NAO	U.S. Naval Academy
NASA/Wallops Flight Center	U.S. Naval Civil Eng. Lab
NOAA (NOS, NWS)	U.S. Naval Fac. Eng. Com.
SAD	U.S. Naval Oceanographic Off.
SAW	U.S. Naval Research Lab

### Colleges/Universities:

California Inst. of Tech.	Stockton State College
East Carolina University	University of Akron
Florida Inst. of Tech.	University of Delaware
Harvard University	University of Florida
Naval Post Graduate School	University of Maryland
NC State University	University of Miami
Old Dominion University	University of North Carolina
Oregon State University	University of N. Colorado
Prince George's College	University of Rhode Island
Rutgers University	University of Virginia
Scripps Inst. of Oceanography	Va. Inst. of Marine Science
Southern Illinois University	

### Others:

City of Va. Beach, VA	MEC Systems Corporation
Coastal Barge Corporation	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	Offshore Coastal Technologies
Coastal Science & Eng., Inc.	Mr. Rowland
Dr. Galvin	Mr. Savage
GEOMET Tech., Inc.	Sea Port Supply Corp.
Greenhorne & O'Mara, Inc.	Shell Development
Dr. Hylton	Sherwood Industries
Mary Marr, Inc.	Mr. & Mrs. Valpey
Mr. Mason	WCTI-TV
Masonite Corporation	SEASUN Power Systems

### Foreign:

W. F. Baird & Asso. Coastal Engineers, Ltd (Canada)  
Queen's University, Ontario (Canada)  
Ministry of Construction, Coastal Division (Japan)  
Norwegian Hydrodynamic Laboratories (Norway)  
University of New South Wales (Australia)  
University of Sydney (Australia)